An agro-ecological model of the peach tree-*Myzus persicae* aphid system and its use to evaluate and design integrated management scenarios.

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Abstract :

Integrated Fruit Production (IFP) has called for an adaptation of production processes to improve crop quality and environmental safety. To reduce the intensive use of pesticides, biological and cultural control methods are proposed as driving forces of top-down and bottom-up pest control. We employed a modeling approach to address on these bases the question of crop-pest management on the *Prunus persica* (L.) Batsch - *Myzus persicae* (Sulzer) (Hemiptera: Aphididiae) biological system.

Firstly, we developed an agro-ecological model by integrating into one complex system four models describing (i) peach-aphid interactions as controlled by winter pruning and nitrogen fertilization, (ii) aphid insecticide induced-mortality, (iii) development of *Harmonia axyridis* Pallas (Coleptera: Coccinellidae) used as a biological control agent, and corresponding predation of aphids, (iv) and fruit quality.

Secondly, we performed simulations of management scenarios which combined different levels of cultural control (winter pruning and nitrogen fertilization) with theoretical pest control strategies, including no treatment (‘*no treatment’*), chemical treatments only (‘*conventional’* and ‘*organic farming’*[1]), and both chemical and biological treatments (‘*integrated’*). We studied on this basis the relationships between control variables and system performances described by various criteria, from productivity to environmental protection. We showed that (i) agronomical performances were largely controlled by cultural practices, while pest pressure was largely controlled by pest control practices, and (ii) when no chemical treatment was applied, nitrogen and winter pruning influenced pest numbers.

Thirdly, we used a multi-objective optimization approach to design new management scenarios for three virtual farmer's production profiles (i.e., productive-economic, productive-sustainable and qualitative-environmental) while considering trade-offs between antagonist performance criteria. For this, we coupled the model with a module of design and generation of management scenarios using a fuzzy evolutionary aggregative approach. The optimal scenarios for ‘*no treatment*’ and ‘*integrated*’ strategies, contrary to the two other ones, varied between the production profiles. The optimal values for cultural control variables could be very different from one strategy × profile combination to another.

[1] Here ‘organic farming’ is a strategy that is limited to the usage of insecticides authorized according to farming guidelines. Such insecticides are generally less effective against pests than those used in conventional systems.

This study demonstrates that agro-ecological and multi-criteria crop-pest simulation models, associated with simulation-based evaluation and multi-objective optimization, have high potential for the implementation of IFP.